PHYSICIAN SUPPLY: A REVIEW OF THE LITERATURE AND AN ANALYSIS OF PHYSICIAN SUPPLY FUNCTIONS

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THESIS

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THE LITERATURE AND AN ANALYSIS
OF PHYSICIAN SUPPLY FUNCTIONS

by

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Physician Supply: A Review of the Literature and an Analysis of Physician Supply Functions

by

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I. INTRODUCTION

There is a general consensus throughout the United States that there exists a crisis in the nation's health care delivery system. In general, the shortage of health manpower, and specifically of physicians, is a major element of the problem. Despite recommendations from various quarters to shorten the training period, increase physician productivity, and/or construct new buildings, medical schools appear not to have been particularly responsive to the increased demand for physicians.

Focusing on the supply of physicians per se, with a goal of constructing a functional equation, a review of the literature then examines the historical production of physicians since the publication of the famous Flexner Report of 1910. Since the shortage of engineers and scientists in the 1950's bears some resemblance to the physician shortage, work of that period is inspected. Various meanings of shortage are discussed to make this comparison. American Medical Association policies are examined to determine their effect on this supply function. With this groundwork, one is then able to formulate a set of structural equations which explain what influences the supply of physicians in any particular year. These structural equations serve as a guideline for the construction of behavioral equations which describe physician supply in detail. Finally the problem of physician supply in the Navy is examined with regard to the above factors and parameters.

II. SURVEY OF BACKGROUND MATERIAL

In canvassing the literature on the supply of physicians, one is immediately struck with the paucity of research in this area. Although the United States has been concerned with the shortage of physicians since the 1930's, only recently has concentration centered on the supply side of the question.

Traditionally economists investigating the doctor shortage have concentrated on analyzing the discrepancies between demand and supply -- a shortage. In 1933 Lee and Jones utilized a "needs approach." Based on expert opinion, they estimated the total number of physician hours it would require to prevent, diagnose and treat each major disease and injury for a population of a given age/sex composition. By assuming the average physician would work a forty-hour week, fifty weeks a year, they concluded that the nation would require 135 physicians per 100,000 persons to achieve the stated goal. Today the current physician population ratio is in excess of 150 per 100,000, medical science has certainly progressed since the 1930's, and there are more paramedical personnel per capita now than in the 1930's [1].

In The Doctor Shortage, Rashi Fein devotes one chapter to the "Supply of Physicians". However he is "interested not directly in physicians, but in the supply of services, and the contributions these services make to health and thus in the level of health itself," again sidestepping the actual

questions centered on the supply side. He attempted to get around the proxy of physician-patient ratio mentioned earlier. Although the proxy is inadequate, because it does not measure physicians' services, does not include an adjustment for quality, and ignores changes in productivity and advances in medicine, this proxy was used again because of the complexities involved in obtaining or constructing any other measure. On the supply side, the number of physicians has been the only available measure and consequently served as a useful first approximation to the quantity of physician services available. After examining the trends of numbers of physicians, the physician-patient ratio (see Table I) and numbers of schools and graduates (see Table II), Fein mentioned the controversy concerning increasing the number of student admissions [2]. There were those who felt admissions to medical schools could be increased without lowering the quality of the student admitted or lowering the quality of education offered. He mentioned quality of the student (as measured by undergraduate grades) as related to quality of the medical school education and the undergraduate quality of his subsequent performance as a physician. In other words, does a medical student's grades have any relation to performance in medical school or later as a physician? Secondly, he asked if the nation's health would be better served with more physicians even of somewhat lower quality, on the average, or with fewer of higher quality.

TABLE I

Doctors of Medicine and Number per 100,000

July 1, Selected Years

Year	Number of Physicians[a]	Number per 100,000 Population[b]
1900	119,749	157
1906	134,688	158
1910	135,000	146
1916	145,241	142
1921	145,404	134
1927	149,521	126
1931	156,406	126
1936	165,163	129
1942	180,496	134
1949	201,277	135
1955	218,061	132
1957	226,625	132
1959	236,089	133
1962	257,035	136

Source: Data through 1957 from U.S. Public Health Service, Health Manpower Source Book, Sec. 9, Physicians, Dentists and Professional Nurses (1959), p. 9. Data for 1959 and 1962 from Milton Friedman and Simon Kuznets, Income from Independent Professional Practice, Sec. 14, Medical Specialists (1962), p. 3.

[a] Excludes June graduates of the year concerned.

[b] Population base includes armed forces overseas.

TABLE II

Medical Schools and Graduates, Selected Years, 1880-1966

Year	Number of Medical Schools	Number of Graduates
1880	100	3,241
1890	133	4.454
1900	160	5,214
1902	160	5,009
1904	160	5,747
1906	162	5,364
1908	151	4,741
1910	131	4,440
1915	90	3,536
1920	85	3,047
1930	76	4,565
1935	77	5,101
1940	77	5,097
1945	77	5,136
1950	79	5,553
1955	81	6.977
1960	85	7,081
1962	87	7,168
1964	87	7,336
1966	88	7,574

Source: Data for years up to and including 1935 from R. G. Leland, Distribution of Physicians in the United States (American Medical Association, 1936), p. 2; for later years from Journal of the American Medical Association, Vol. 198, No. 8 (Nov. 21, 1966), p. 868.

Since Fein's chapter was concerned with the "supply of physicians," he did not deal directly with these questions, nor did he do more than point out the existing disparities in physician distribution due to geography, specialty, age, or type of practice. Instead he discussed supply projections, centering concern on two questions: (1) Can the increase be accomplished without a relaxation of quality standards? and, (2) What growth in the total number of physicians is implied by the growth in the number of graduates? With over 13,000 graduates expected in 1975, and an 18 percent increase in the 1965-75 decade, he used figures from the Bureau of the Census to provide an encouraging answer to the first question. The number of persons age 22 will grow by 29 percent during the same period and the Office of Education estimated bachelor degrees granted will expand by 52 percent. Consequently the medical schools will have a significantly larger pool from which to draw their students, presumably of comparable quality. In answering the second question, he concluded that the physician population ratio would remain relatively steady during the period [3].

By centering on supply projections, he neglected the aspects which influence physician supply. The discussion of physician-patient ratio focused on the number of physicians while neglecting the possible increase in productivity. It also focused on the population and neglected possible increases in demand.

An early and still highly influential study of physician shortage was included in Milton Friedman and Simon Kuznets' study of professional practice. They investigated five independent professions (medicine, dentistry, law, certified public accounting, and consulting engineering) using data from 1929-36. Probably their most important conclusion was that there existed a shortage (i.e. price of an item exceeding its cost, including a normal profit) for each profession; that is, the additional returns outweighed the additional costs of acquiring a professional education for all the professions surveyed. They cite the cause as follows:

> "At present, the limitations on the number of persons in a position to enter the professions must be considered the basic reasons for the difference between extra returns and extra costs; more basic even than the difference in ability needed. A sizable number, perhaps a majority, of all young men are unable to enter the professions because they cannot make the necessary capital investment or for other reasons. If these hindrances were removed, the reservoir of persons unable to enter the professions could surely furnish many persons as able as those who now embark on professional careers." [4]

During the period concerned, physicians on the average, earned 32 percent more per year than did dentists, although ordinary economic forces could account for no more than half this difference, which Friedman and Kuznets attributed to "the greater difficulty of entry into medicine." This difficulty they attributed to an effect of public policies designed to raise the quality of medical education or as a deliberate policy of limiting the number of entrants in order to keep down the total number of physicians, that is to

prevent "overcrowding" of the profession, such as accrediting medical schools and licensure laws [5].

Kessel has done extensive work analyzing the economic implications of the control exercised by the AMA over the education, licensure and pattern of practice of American physicians (addressed later). M. F. Bognanno and J. R. Jeffers have extended his work and view the "persistence of (doctor) shortages over the long run as a market imperfection reflecting serious misallocation of resources involving significant unwarranted social costs. Internal rates of return of medical education and levels of physician income that are substantially above those earned in more competitive markets are interpreted as evidence of the existence of market imperfections." Organized medicine maintains that higher quality is achieved by limiting the number of applicants admitted to medical school. Bognanno and Jeffers however determined the actual social cost to consumers of the restrictions in the physician market, asking whether the "quality" or value of additional benefits offset that cost. To do this they let $\bar{\beta}$ represent the rate of growth in per capita outlays on physician services and $\bar{\gamma}$ represent the observed rate of growth of physician income over time. Then if $\hat{Y}_t$ represents the average predicted physician income at time t, Y_t represent the average physician income at time t, or

$$\hat{Y}_t = (1 + \bar{\beta})^t Y_o$$

$$Y_t = (1 + \bar{\gamma})^t Y_o$$

Further if a constant ratio supply policy has been followed in the past $(\overline{\beta} - \overline{\gamma}) = 0$. The null hypothesis that $(\overline{\beta} - \overline{\gamma})=0$ is rejected at the .01 level, indicating that the growth in average physician income is consistent with the implications of the constant ratio supply hypothesis. Their conclusion is that quality does not offset additional cost and the supply restrictions should be removed, unless organized medicine can clearly show that the "quality" of medicine would then decline [6].

"National health care" policy in itself is a vague construct. Since there did not then exist an operational definition of "adequate health care," Carl M. Stevens in his work took a basic health care plan and considered its provisions as a guaranteed "floor" or minimum. Taking the Kaiser Health Plan of Portland Oregon of 1967 as a model, he asked: What number of physicians would be "required" if the population as whole utilized physician services at the same rate as do these members? This "required" number was then compared with the number of physicians actually available. He addressed three areas of concern: (1) Kaiser utilization rates and Kaiser physician output, (2) Kaiser utilization rates and U.S. physician output, and (3) U.S. utilization rates and U.S. physician output. Having restricted his consideration to the Portland Metropolitan area, he then projected his figures to Oregon as a state and the U.S. as a nation. He found that the 1174 non-Federal physicians in the Portland area exceeded the "required" number for Kaiser

utilization rates and Kaiser physician output (655); for Kaiser utilization rates and U.S. physician output (800) and even for U.S. utilization rates and Kaiser physician output (1000). However these excesses did not necessarily indicate that a shortage did not exist, since utilization rates and physician output rates are not in themselves measures of demand and supply. That is to say Kaiser physicians may limit the amount of health care supplied, despite a demand for a greater quantity. Nor was the question of actually organizing and implementing any of the locations into such a health care system addressed. A short run solution (not considering increasing the supply of physicians) suggested two alternatives: (1) Increase the supply of physician services without increasing the number of physicians -- increase physician productivity, (2) Decrease the demand for physician services. These he characterized as only possibly feasible, and rather unlikely. Allowing the disequilibrium to run its course with concomitant rises in costs and prices has become increasingly unacceptable to the consumers of medical services given the present imperfections in the market structure. His final alternative therefore was a form of non-price rationing or price control, either by relying on some form of voluntary restraint or in national health insurance legislation, or a combination of both [7].

Recently Charles Stewart and Corezon Siddayao, have attempted to focus concern not on the shortage of physicians, but on physician distribution by area and specialty. They

recognized the shortage only as a short term problem already somewhat relieved by an increase in medical schools and their enrollment in the 1950's; as well as the continuing infusion of foreign trained physicians. Whether the target was to eliminate the assumed shortage of 50,000 of 1973, attain the ratio of the highest census division, or the ratio of the highest state, they argued that it would eventually have occurred even without the effects of the 1964 legislation, possibly even by the late 1970's. With the surplus of qualified applicants to medical school, the high levels of physicians' incomes and the recent rapid increase thereof, they maintained that subsidies to medical students have no justification. Instead they recommended a reorganization of the medical care system by economizing on the scarce resource -- physicians. Their productivity could be increased by delegating more tasks to paramedical personnel and closing the vertical gap in the medical hierarchy, i.e. providing opportunities for paramedical personnel to advance through experience, training, and certification to the status of physician. Another alternative suggested was the revision of medical education to shorten the program through a reduction of the four years of college before medical school and curtailing the period of medical school training. Although they suggested these ways of increasing the supply of physicians, they seriously questioned the need to increase the supply, noting however, that since the supply of medical services is determined by consumer demand under conditions of near-zero

pricing as a result of third party payments, the shortage may never be eliminated.

Significantly, they also discussed at length the influx of foreign medical graduates (FMGs) to the physician supply. That they are an important input was evidenced by recent news items as well as the fact that 23 percent of the licences issued in 1969 alone were to physicians originally coming from foreign schools. In 1973, it had risen to nearly half. During the decade from 1959-69 the proportion of those physicians on record with the AMA rose from 8.6 to 18.4 percent. It appeared that FMGs accounted for 46 percent of the increase in practicing physicians during that time. In 1951 FMGs filled 2000 positions or about 10 percent of all hospital internships and residencies. By 1959 the proportion rose to 23 percent and in 1969 the number was at 14,500 and the percentage at 32. As a matter of fact, in view of the above, the authors expressed surprise that legislation did not focus on this source of supply, which would surely dwindle with the elimination of a shortage rather than be faced with trying to mothball medical schools [8].

Frequently, the presence of many foreign physicians in this country has been cited as proof in itself of the shortage of medical school output. Klarman holds that immigrants were attracted to the U.S. as a better place to work and live and cited the reason for more FMGs in hospital staffs as a difference in requirements for house staff training and health services in general [9].

James Jonish investigated the entrance of FMGs during the period 1963-68. He held that the lag in supply adjustments in the U.S. (increases in U.S. relative physician incomes and continued vacancies in residencies and internships) was what attracted foreign medical manpower. With the introduction of the U.S. Immigration Act of 1965, immigration of FMGs in 1967 and 1968 was more than 50 percent above the 1965 levels. In absolute numbers, the bulk of those physicians came from less developed countries [10].

It is Michael Lynch's conclusion, after reviewing the literature, that the physician shortage has become worse since the 1950's due to an increased demand or willingness to pay on the part of the public. But as proof that the "economists' mirror is a bit foggy," he says there is no consensus on whether an increase in the number of physicians would lead either to lower fees or to a better geographic and social distribution of physicians [11].

III. PRINCIPLES OF THE ENGINEER SHORTAGE APPLIED TO THE PHYSICIAN SHORTAGE

In the 1950's one heard frequent and loud complaints of a shortage of engineers and scientists, which might have been taken as an indication of a failure of the pricing mechanism. There were then also vague proposals for interference with market determination of numbers and allocation. But the shortage was exactly what would be predicted by classical theory in the face of rising demand. As a matter of fact, as proof that the market is working, until recently, one heard no complaints of engineer shortage. Despite the temporary resolution there are indications another engineer shortage is possible in the near future.

In the 1970's though one hears echoes of a similar shortage -- that of physicians. What are the similarities between this shortage and that of engineers during the 1950's? Much work was done then examining that shortage, and one might suspect that some similarities would exist.

Equality of supply and demand is a central tenet of ordinary economic theory, but only as an end result of a process, not as a state holding at every instant of time. Inequalities between supply and demand are usually regarded as an integral part of the process by which the price on a market reaches its equilibrium position. Price is assumed to rise when demand exceeds supply and to fall in the contrary case. In the sense of an excess of demand over supply, a shortage

is the normal accompaniment of a price rise. If stability of the market is assumed, then the shortage observed is transitory and disappears as equilibrium is reached. However if the demand curve steadily shifts upward, the shortage will persist and the price will continue to rise.

In their study, An Economic Analysis of the Market for Scientists and Engineers [12], economists Alchian, Arrow, and Capron defined several meanings of "shortage". If there are chronic vacancies in the job market, a situation that persists indefinitely in which more engineers are demanded at going salaries than are supplied, a shortage exists. Second, there may be such vacancies only temporarily because salary adjustments lag behind a rising market demand, a situation with policy implications markedly different from the first. Third, the word shortage is sometimes applied to any situation where prices or wages rise, with the result that some potential buyers are priced out of the market, although no greater quantity of the commodity or service in question is demanded at the new price or wage than is supplied. Fourth, a very different meaning of shortage is that market demand is less than it "ought" to be. This usage can reflect either a misunderstanding of the workings of a market economy, an appreciation of the deficiencies of the market mechanism, or an over-all rejection of the test of the market.

In explanation of the first two cases, we look at Marshall's well-known analysis. His formulation distinguished two equilibria, short-run and long-run. On the usual price-quantity diagram, (see Figure 1) if P_1 is the initial price,

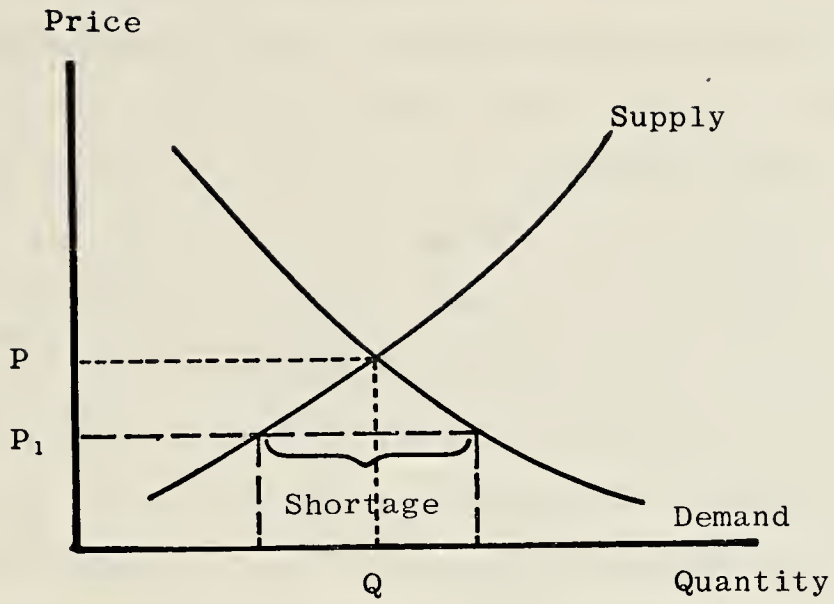

Figure 1

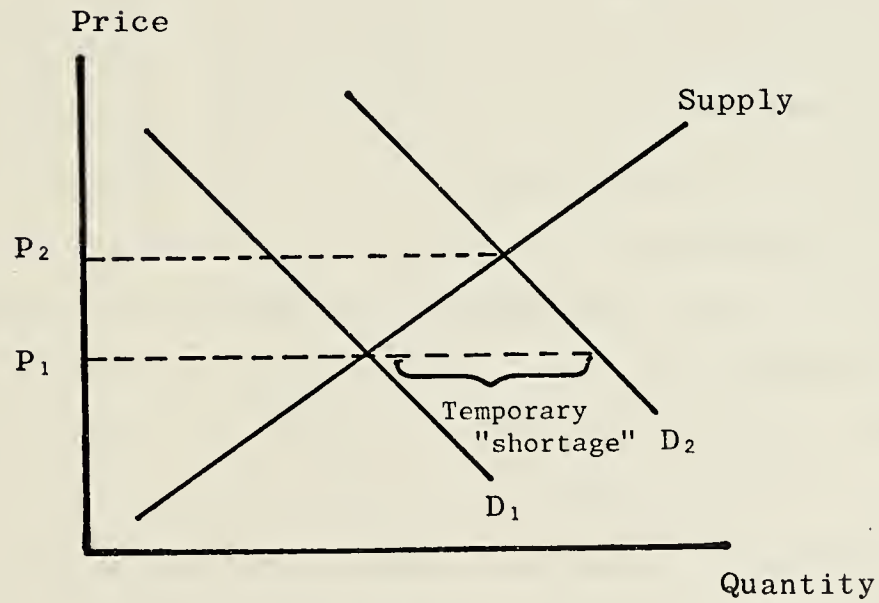

Figure 2

one expects the existence of a shortage to raise the price gradually to the equilibrium value P. During the process the shortage decreases to zero. The shortage can persist only if the price is held at some value such as P_1 by an outside force, such as price control. In that case we have a shortage due to a fundamental imperfection of the market.

On the other hand, assume a market which is initially in equilibrium, e.g. the market for engineers and scientists. We suppose further that the price of a commodity that uses engineers in its production has increased. If each firm producing this commodity was in equilibrium before the increase in the commodity price, if it had as many engineers as it wished to hire at a given salary level, then the number of engineers that it would pay the firm to hire at the previous salary has increased, and therefore the market demand has risen. In Figure 2, D_1 represents the original demand curve, while D_2 represents the new demand, rising from some change in external conditions. It is well to note that this demand is, in effect, a derived demand, that is the demand is not for engineers per se, but for the services they provide. After the demand curve has shifted to D_2, the price that would bring supply and demand into equilibrium is P_2. But movement to this price or salary level typically will take time. At the moment of the shift the market is experiencing a shortage, which in many respects is comparable to what it would face under price control. This is called then the "dynamic shortage" during the shift.

For the third definition of shortage one looks at the important study of the engineer-scientist market by Blank and Stigler [13]. They settled on the following definition: "A shortage exists when the number of workers available (the supply) increases less rapidly than the number demanded at the salaries paid in the recent past. Then salaries will rise, and activities which were once performed by (say) engineers must now be performed by a class of workers less well trained and less expensive." [14]. They relied primarily on a comparison of the earning of engineers with the earnings of other professional groups and wage earners in order to test the hypothesis of a shortage of engineers. By definition a shortage existed if the relative earnings of engineers had risen. In the light of their definition and their concern with only long-run trends, their conclusion was that there has been no significant shortage. Furthermore since 1950 the relative change in salaries of engineers has been so slight that the shortage could not have been serious. Also by their definition, the rise in average starting salaries for college graduates from 1950 to 1956 merely indicated that there was a general shortage of college graduates.

Finally the fourth meaning of shortage may embody some social criterion. For example, some people may say there are not as many engineers and scientists as this nation should have in order to do all the things that need doing, such as maintaining our rapid rate of technological progress, raising our standard of living, keeping us militarily strong,

etc. One might really read these statements as the demand (in the economic sense) for technically skilled manpower ought to be greater than it is -- it is really a shortage of demand for scientists and engineers which concerns them.

Another implicit definition is that since the U.S. does not have as many engineers and scientists as the Soviet Union, it therefore has a shortage. One other explanation possibly exists similar to that explanation of the "servant shortage" of World War II days. When higher wages in alternative lines of employment developed for those who had previously been servants, they were lured away and could no longer be hired for household help at their previous wages. Rather than admit they would not pay the wages necessary to keep help, many found it more felicitous to speak of a "shortage."

As Alchian, Arrow, and Capron developed their model of dynamic shortages and price rises, they also defined the ratio of the rate of price rise to the excess of demand over supply as reaction speed. Focusing on the average price being paid for engineering services, it was clear that this price would tend to rise so long as there was an excess of demand over supply, but it would not rise instantaneously to the level that would bring supply and demand into equality. The greater the excess of demand over supply, the greater the rate of increase of price per unti of time. Alternately, price will cease to rise when the price is such that demand equals supply. Keeping in mind the above definition of

reaction speed, the amount of shortage will tend to disappear faster the greater the reaction speed and also the greater the elasticity of supply. In a linear approximation then if D is demand, S is supply, t is time and p the average price:

$$(1) \quad dp/dt = k(D-S),$$

$$(2) \quad D = ap + c,$$

$$(3) \quad S = bp + d.$$

Equation (1) expresses the assumption about the relation between price rises and the difference between supply and demand; equations (2) and (3) are the simple demand and supply functions. If X is the shortage (D-S) then

$$(4) \quad X = -(a + b)p + (c - d).$$

Differentiating with respect to time and substituting in (1) yields:

$$(5) \quad dX/dt = -k(a + b)X$$

Hence, for any given shortage X, the speed of convergence is greater the greater k(a+b). Specifically, other things being equal, the smaller the value of b, the slower will be the convergence of the shortage X to zero. To deal with a steady upward shift in demand equation (2) is expanded to:

$$(6) \quad D = -ap + c + et$$

where e is the rate of increase of demand with time for any given price. Again letting X be the shortage equation (4) becomes

$$(7) \quad X = -(a + b)p + (c - d) + et$$

Differentiating with respect to time yields:

$$(8)\quad dX/dt = -(a + b)(dp/dt) + e$$

If $X = D - S$ then equation (1) can be rewritten as:

$$(9)\quad dp/dt = kX$$

Substituting now again: into equation (8):

$$(10)\quad dX/dt = -(a + b)kX + e$$

Assume that there is no shortage at the beginning, so $S = D$ or $X = 0$. Then equation (10) shows $DX/dt > 0$, so that the shortage X begins increasing and must continue to increase. It also follows that

$$(11)\quad \lim_{t\to\infty} X(t) = e/(a + b)k$$

so that the shortages tend to a limit which is greater the greater the rate of increase of demand (e) and the slower the speed of adjustment would have been with an unshifting demand schedule. Differentiating equation (9) with respect to time once again and substituting in (8):

$$(12)\quad d^2p/dt^2 = k\, dX/dt = k(a + b)(dp/dt) = ke$$

As reasoned earlier now dp/dt must be increasing over time, positive for all t, therefore the price p must be increasing steadily. If p^* is the price which would clear the market (i.e. make $X = 0$) then (7) becomes:

$$(13)\quad 0 = -(a + b)p^* = (c - d) + et$$

or multiplying through by k:

$$(14)\quad 0 = -k(a + b)p^* + k(c - d) + ket$$

If q is the excess of the market-clearing price over the actual price i.e. $q = p^* - p$, substituting from (7) into (9):

$$(15) \quad dp/dt = -k(a + b)p + k(c - d) + ket$$

Finally subtracting (14) from (15) and using the definition of q:

$$(16) \quad dp/dt = k(a + b)q$$

Since dp/dt is positive and increases from zero to a limit, the same must be true of q [15].

Thus the actual price will always remain below the market-clearing price and the gap will actually widen with time, but the two time paths will converge. That is, the continuing increase in demand causes the price to increase steadily and indefinitely, but it always remains below the price that would clear the market.

Perhaps at this point it would be beneficial to briefly trace the sequence of events observed in the market as a result of the shift in the demand curve. A particular firm may not know exactly how many more engineers it could profitably hire, but is only aware that it wants more. Advertising at the going salary, there are no takers, so the firm realizes that in order to hire it must pay higher salaries. The firm must naturally reconsider its desire to hire, given that salaries have risen, i.e. will the marginal product of additional engineers cover the higher level of salaries? The firm will decide eventually to hire, but the process has taken time. The time lag in the firm's reaction therefore

is spent partly in learning about the supply conditions in the markets, partly in determining the profitability of additional hiring, and partly in the internal hiring mechanism of the firm itself.

Now the firm may not have hired as many as would have achieved maximum profitability. Even if they had, the market as a whole would still not be in equilibrium, since considering the old employees earning the old salary, there is more than one price being paid for identical services. The market mechanism adjusts with other firms hiring the lower paid engineers at higher salaries, or their original firm keeps them by matching this higher salary. In any event, these information flows and decision processes take time.

The total lag in the response of salaries to a shortage is then compounded out of the time it takes the firm to recognize the existence of a shortage, the time it takes to decide upon the need for higher salaries and the number of vacancies at such salaries, and the time it takes employees to recognize the salary alternatives available and act upon this information or the time it takes the firm to equalize theirs with outside offers.

Having offered this preliminary explanation of the single shift of the demand curve, Alchian, Arrow, and Capron then considered the situation of continuing change in demand (or supply). They suggest that that was the case for engineer-scientists since about 1950, i.e., if the demand curve is rising steadily then as the market price approaches the

equilibrium price, equilibrium price steadily moves away from the market price. A chronic shortage then exists in the sense that buyers at any given moment will desire more of the commodity at the average price being paid than is being offered, and the amount of the shortage will not approach zero. And this condition would continue as long as demand is increasing. In the market for engineer-scientists, then there existed a dynamic shortage, that is a situation in which there are unfilled vacancies in positions where salaries are the same as those being currently paid in others of the same type and quality. The magnitude of the dynamic shortage depends upon the rate of increase in demand, the reaction speed in the market, and the elasticity of supply and demand. The reaction speed in any particular market depends partly on institutional arrangements, such as the prevalence of long term contracts, and partly on the rapidity with which information about salaries, vacancies, and availability of personnel becomes generally available throughout the market. The adjustment process took a day in Marshall's example of the corn market, whereas it was much longer in the market for engineers and scientists.

They further reason that the dynamic shortage is a possible explanation because (1) there had been a rapid and steady rise in demand, (2) the elasticity of supply was low especially for short periods, and (3) the reaction speed on the engineer-scientist market may be expected to be slow.

(1) Now the increase in demand for engineers and scientists was for those utilized in research and engineering, explained chiefly by the action of the government in contracting for reserach and development work by private industry.

(2) The elasticity of the supply of engineer-scientists with respect to price changes was expected to be small but not zero over short periods of time, owing to the length of time it took to train new personnel.

(3) Three factors may cause the reaction speed to be slower for the engineer-scientist market. They were the prevalence of long-term contracts, the influence of the herogeneity of the market in slowing the diffusion of information, and the dominance of a relatively small number of large firms in research and development. Any one firm may feel that increasing salaries in order to attract more scientists and engineers will set off competitive bidding resulting in no substantial change in distribution but a considerably higher salary bill. It is also to be noted that not only is the number of firms small, but the typical firm size is large. In particular, a single buyer, the government, directly and indirectly accounts for about half of the total demand.

As far as policy implications are concerned; different approaches were to be used depending on whether a dynamic shortage exists or a shortage due to a price control. If artificially imposed restrictions either on demand or supply in some market were causing rigidity such that price was

prevented from rising sufficiently to restore the market to anequilibrium, one should have considered the removal of such restrictions. On the other hand, if a dynamic shortage existed, only a lag in adjusting to new circumstances was involved -- an inherent characteristic of the market and only when lags result in prolonged and serious departure from equilibrium conditions, should intervention occur. The only possible policy they suggested was to allow prices to rise. They offered two reasons why "excess demand" should be eliminated by the necessary rise in salaries: (1) salary increases serve as the signals which call forth the increase in supply in the long run and (2) those using the services of scientists and engineers should be faced with the true price of those services if they are to use them economically.

Alchian and Arrow concluded that the dynamic shortage developed due to the very rapid increase in demand in the market and the failure of the price of services to adjust upward as rapidly and by as large an amount as warranted by the increasing demand, given the supply schedule of such services. In view of the relative rigidity in supply and despite the great price rise, the market must be permitted to react to the increase in demand, thereby allocating engineer-scientists in the short run and bringing forth the increased supply in the long run.

Before classifying the present physician shortage as similar to the "dynamic shortage" of engineers, one must eliminate from consideration the other types of shortages

enumerated in the Alchian, Arrow, Capron study. Since they labeled chronic vacancies (where more was demanded than could be supplied at going salaries) as one type of shortage, one might convincingly argue that this is the case in the physician market. They maintain that such a shortage will result from wage control or other restrictions that prevent prices from rising. Although wage controls for health care were in effect for a short period, it was not of sufficient time to cause the shortages presently witnessed. Restrictive policies will be addressed in the next chapter. Another meaning of shortage introduced was that of a price rise forcing some consumers out of the market. Although prices of physicians' services have risen, the enfranchisement of the population through third party payments such as Medicare or Medicaid has more than offset this effect. The final meaning of shortage was that there are less than there "ought" to be, clearly outside the economist's meaning of shortage. The meaning upon which Alchian, Arrow and Capron settled with this: a shortage resulting from sluggishness in market adjustments when there are rapidly rising demands, or a "dynamic shortage." They documented in detail the parameters which determine the magnitude of this "dynamic shortage." In review they were the rate of increase in demand, the elasticity of supply and the reaction speed in the market.

In the market for physicians there has been a myriad of documents discussing the increased demand with the introduction of Medicare, Medicaid, OEO programs and third party

payments during the past decade. These methods of financing have resulted in a rapid and steady rise in demand. Such an increase would put a strain on the smooth functioning of any market. The elasticity of supply with respect to price changes may be expected to be small over short periods of time, owing to medical school entrance policies and the length of time it takes to train physicians. In any event the responsiveness of supply is less than for commodities such as manufactured goods, due to the importance of non-economic factors in choosing a career and uncertainty of rewards in the distant future. Finally, reaction speed as they defined it, depends partly on institutional arrangements such as the prevalence of long term contracts, and partly on the rapidity with which information becomes available. In the physician market the only factor playing a part would be the transference of information; there simply are not long term contracts in the practice of private medicine.

Whereas these economists argued that the market should be allowed to operate freely in letting prices rise to call forth more engineers eventually, there is some hesitancy on the part of economists to say that prices paid physicians should also rise to call forth and increase in supply. Why? Partly due to the rates they already receive, but partly due to the fact that present policies would simply not allow more students to enter medical schools, as will be investigated next.

IV. THE AMA AND MEDICAL SCHOOLS

Throughout the economy, the supply of goods and services is governed by the net return from their production as compared with net returns realized from using the same resources elsewhere, the traditional concept of opportunity costs. As discussed above, the market is cleared at the price equating supply and demand, given conditions where the sellers are willing to supply certain goods and services and buyers want and are able to pay for them. Price serves as a rationing function. The market pricing mechanism also applied to medical care services. In response to higher prices due to increased demand, additional supplies would tend to be called forth, although certain factors prevent the system from operating as conventional theory suggests.

Imperfections exist in the medical care market on both the demand and supply sides. For example on the demand side, the physician assumes the unique role as a decision maker in determining what medical goods and services the patient needs, although patients still have the option of accepting or rejecting the doctor's advice. Physicians are in a position to decide when a condition requires hospital confinement and how long a patient has to stay -- a decision which in part affects the amount of goods and services supplied. Naturally then to the extent that the ability of supply to create its own demand in the above sense exists, attempts to relieve shortages by increasing supply are particularly frustrated. On the

supply side we will investigate the non-competitive elements of the market. Entry into the market is restricted not only through medical schools but also through licensing, certification, or membership requirements in professional societies. Membership in county or state societies is sometimes necessary for the use of hospital facilities [16].

In examining the supply side then of this imperfect market, one sees some institutional aspects affecting the factors of supply. In their study Increasing the Supply of Medical Personnel, Stewart and Siddayao say that the aggregate flow rate at which physicians are supplied is affected by:

(1) time lags in graduating personnel and building facilities

(2) entry limitations to medical schools and the rate of attrition in such schools

(3) licensing requirements for physicians

(4) rate of retirements and deaths in the profession

(5) returns to those supplying medical care

(6) the existence of a vertical gap in the hierarchy of medical personnel [17].

Significantly the American Medical Association has direct influence over four of the above mentioned, indirect influence on the returns to physicians and no influence over the retirements or deaths in the profession.

Reuben Kessel has done extensive analysis on the economic implications of the control exercised by the AMA over the

education, licensure, and pattern of practice of American physicians. In particular, he argues persuasively that, armed with the famous Flexner Report, the AMA has acquired significant monopoly power over medical markets, resulting in the existence of substantial "monopoly returns to an investment in medical education" [18].

Before examining the Flexner Report and its implications for the AMA, one must look at the production of physicians prior to Flexner's publication in 1910. Medicine, like the profession of economics today, was a relatively competitive industry, until the founding of the AMA. With very few exceptions anyone who wanted to practice was free to hang out a shingle and declare himself available. Medical schools were easy to start, easy to get into, and provided, as might be expected in a free market, a varied menu of medical training that covered the complete quality spectrum. These variations could be broken into two basic types of educational programs. In one, often conducted by independent proprietary institutions and sometimes owned by the faculty themselves, the student undertook a didactic program that lasted one or two years. In some cases attendance was not considered necessary as long as the prescribed examinations were successfully completed. In the second program, one would simply apprentice to another physician. Consequently in one case, medical education was unrelated to medical care whereas in the other, medical education was incidental to participation in the provision of medical care.

In 1847 the American Medical Assocaition was founded and immediately committed itself to two propositions that were to lead to sharp restrictions upon the freedom of would-be doctors to enter the medical profession and the freedom of patients to choose doctors whom the AMA felt were not adequately qualified to practice medicine. These propositions were (1) that medical students should have acquired a "suitable preliminary education," and (2) that a "uniform elevated standard of requirements for the degree of M.D. should be adopted by all medical schools in the United States [19].

These objectives were achieved in two stages [20]. During the first stage, the primary concern of the AMA was licensure of physicians. In the second, it was accrediting schools of medicine. During the first stage, which began with the founding of the AMA and lasted until the turn of the century, organized medicine was able by lobbying before state legislatures to persuade legislators to license the practice of medicine. Consequently the various states set up boards of medical examiners to administer examinations to determine whether or not applicants were qualified to practice medicine and to grant licenses to those the State Board deemed qualified to practice. Generally speaking, organized medicine was very successful in its campaign to induce states to license physicians.

But it was not until the second stage that economically effective power over entry into the practice of medicine was acquired by organized medicine. This stage began with the

founding in 1904 of the Council of Medical Education of the AMA. This group dedicated itself to the task of improving the quality of medical education offered by the medical schools of the day. In 1906, this committee undertook an inspection of the 160 medical schools then in existence and fully approved of the training in only 82 schools. Thirty-two were deemed to be completely unacceptable. In order to gain wide acceptance of the results of this study, the council solicited the aid of the Carnegie Foundation: "If we could obtain the publication and approval of our work by the Carnegie Foundation for the Advancement of Teaching, it would assist materially in securing the results we were attempting to bring about" [21].

Subsequently Abraham Flexner, representing the Carnegie Foundation, with the aide of N. P. Colwell, secretary of the Council on Medical Education, repeated the AMA's inspection and grading of medical schools. In 1910, the results of the labors of Flexner and Colwell were published.

Shrylock interprets the history of medical education during the period from 1870 to 1910 as a struggle between existing practitioners, represented by the AMA, and medical educators for control over the output of doctors and hence over the medical schools themselves [22]. The victor in this struggle was the AMA, and its most powerful weapon in the battle was the Flexner Report. The report discredited many medical schools and was instrumental in establishing the AMA as the arbiter of which schools could have their

graduates sit for state licensure examinations. Graduation from class A medical school, with the rating determined by a subdivision of the AMA, became a prerequisite for licensure. Evidence of the triumph of the AMA against the medical educators was the elimination of the power of medical schools to license their own graduates.

A major thrust of the report was to recommend that medical education should be based much more than it had in the past upon the rapidly developing biomedical sciences. Secondly, medical education was to be related much more intimately to extensive hospital clinical experience combined with laboratory work. This recognition of the need to provide a modern scientific and clinical base as the foundation of medical education, and thus medical care, naturally called for a new range of scientific resources and new forms of organization, in terms of both facilities and personnel. The conclusion followed that many of the proprietary medical schools could no longer serve a useful purpose and should be discontinued. Flexner rated only 72 schools (45 percent) completely acceptable. This led to an adoption of the four-year medical school curriculum, the introduction of laboratory teaching exercises, improvement in the quality of instruction through the development of a greater proportion of full-time faculty, first in the biological sciences and later in the clinical fields, and the expansion of clinical teaching through the introduction of clinical clerkship. The number of medical schools was cut in half from 1900 to

1925, as a result of AMA regulation [23]. Thus the changes that the Flexner Report visualized were achieved through an institutional accreditation process and by the formalization of procedures for licensing the medical practitioner. Confirmation of the fact that the AMA was interested in seeking control over medical schools is provided by the former head of the AMA's Council on Medical Education:

> "In this rapid elevation of the standard of medical education....with the reduction of the number of medical schools from 160 to eighty there occurred a marked reduction in the number of medical students and medical graduates. We had anticipated this and felt that this was a desirable thing. We had....a great oversupply of poor medical practitioners..." [24]

According to Shrylock,

> "Competing within a free economy they observed that the scientific motive for educational reform coincided with their own professional ambitions. They became increasingly aware that too many schools were turning out too many graduates to make practice profitable." [25]

The physician to population ratio has been widely proclaimed as a rough standard of the adequacy of health services generally, and of the adequacy of physician services, in particular. Its close relationship to notions of need and quality enjoy a long precedent perhaps initiated by the late Henry S. Pritchett, former head of the Carnegie Foundation which financed the development of the Flexner Report who states in his introduction,

> "...it seems clear that as nations advance in civilization, they will be driven to throw around the admission to these great professions such safeguards as will limit the number of those who enter them to some reasonable estimate of the number who are actually needed. It goes without saying that no system of standards of admission to a profession

> can exclude all the unfit or furnish a perfect body of practitioners, but a reasonable enforcement of such standards will at least relieve the body politic of a large part of the difficulty which comes from overproduction, and will safeguard the right of society to the service of trained men in the great callings which touch so closely our physical and political life." [26]

But it is not clear that quality of care drops as the number of physicians exceeds those "needed." Economists make much of the fact that the quantity of medical services consumed depends on factors in addition to the "quantity needed" and the fact that the number of "fit" applicants to medical school greatly exceeds the number of actual admissions by three-fold.

It is generally held that an increase in quality requires an increase in price, all other variables held constant. And an increase in price implies an increase in efforts to economize on a resource that has become more scarce. In the case of physician care, an increase in quality implies a greater effort to economize on physician's services. Specifically people would tend to substitute self-diagnosis and treatment for the services of a physician. Therefore, increasing the quality of physicians does not necessarily imply that the quality of medical care that the public as a whole receives also increases, since the public receives a mixture of professional attention and self treatment.

Naturally then, the advent of licensure and the closure of the medical schools that failed to meet AMA standards was justified by the AMA as a measure to protect the public from the ministrations of unqualified or incompetent physicians.

Grandfather clauses protected the rights of existing physicians to continue to practice medicine regardless of the adequacy of their training, so the full effect of the report could not have been realized until many years later.

These restrictive policies were particularly oppressive for Negroes and Jews and probably women. Whereas the number of medical schools were cut in half, the number of Negro medical schools went from seven to two, and the number of students admitted to those also decreased [27].

As a result of the Flexner report and the restrictions of opportunities for medical education in this country, foreign medical schools, particularly in the late 1930's, were deluged by American applicants. If one divides graduate training in United States institutions into the categories of business administration, agriculture, education, engineering, physical and natural sciences, economics, and medicine, then foreign enrollments in American institutions exceed American enrollments in foreign institutions by a wide margin for all fields but one -- medicine. Americans studying abroad range from one-fourth to one-thirtieth of foreigners studying in the United States for six of the seven categories. But the ratio of Americans studying medicine abroad to foreigners studying medicine in the United States exceeded three to one for the year 1966. Apparently the restriction of opportunities this country continues to affect the number of Americans studying medicine abroad [28].

Many distinguished writers have argued for giving the public the freedom to choose anyone as a physician without the constraints imposed by the state, i.e. for free entry into the practice of medicine. This view appears in the letter of Adam Smith to Cullen [29] and in a letter of William James to his fellow physicians in Boston [30]. It is also Milton Friedman's position [31]. By using licensure as a barrier to entry, our society has to a large extent abandoned freedom of choice of physicians. On the other hand, if licensure were available to any applicant, whether the school he attended was accredited or not, it would encourage and pressure medical schools to graduate students capable of passing the examinations and not present the current "double" barrier to entry.

Again Kessel argues that organized medicine has not been consistent in protecting the public from making poor choices of physicians. First, in view of substantial evidence of discrimination against interns on the basis of race, creed, and color in admission to medical schools, organized medicine reduced the quality of student input [32]. Second, when, standards were instituted they were applied only to new graduates, not existing practitioners. Third, there continues to be no re-examination for physicians. To be consistent with a concern for high quality, there should be a re-examination with recertification to insure physicians keep current. Fourth, politics have been intertwined with decisions which should be made on quality alone, i.e. the

requirement that a doctor be a member of his county medical society in order to qualify for membership in a special board. Fifth, staff appointments to a hospital are similar to admissions procedures to a country club -- race, religion, family, type of practice, etc. are as important or more so than skill and talent [33]. Finally, the great internal solidarity and cohesion within the medical profession reduce the incentive to produce quality work and develop an outstanding reputation.

To show the further effects of organized medicine running of medical schools, Kessel contrasts post- and pre-MD training. If educators were in control, with their much stronger interest in producing doctors, they would act to make the output of physicians responsive to consumer desires. There are a plethora of advanced programs for post-MD training under the aegis of hospitals rather than medical schools. Spaces for post-MD training exceeded the output of American medical schools by quite a wide margin [34]. Consequently one finds large numbers of non-American graduates of foreign medical schools taking intern and residency training in this country. Approved residencies in hospitals increased six hundred percent between 1940 and 1960, while the output of medical graduates rose only thirty-five percent. Kessel holds that an explanation of this anomaly is the hypotheses that there exist economic benefits to the medical profession for post-MD training that are virtually nonexistent for pre-MD training, e.g. students in their first two years of

training are dead-weight to a hospital staff, while those who have finished their first four years are extremely useful and therefore highly prized. It is an anomaly, educationally, that the more advanced the training, the greater is the availability of facilities and the more specialized and advanced training often takes place outside medical schools.

Why should there be more facilities for post-MD training than for pre-MD training? A possible hypothesis is there exist economic benefits to the medical profession for post-MD training that are virtually non-existent for pre-MD training. Doctors that are members of the attending staff of a hospital with a large intern and residency program may have an important competitive advantage stemming from their lower cost of producing patient care, since they can delegate duties to the house staff they would ordinarily have to perform for themselves. Therefore the staffs of hospitals without educational programs push hard to obtain such programs. Simply stated, there are no economic benefits of a comparable magnitude for pre-MD programs. First and second year medical students are in fact dead-weight with with respect to instructional costs. Fein and Weber show that tuition and fees account for only four percent of all medical school funds [35].

A further point worth noting is the natural conflict of interest in which the AMA is involved. It has presumed to simultaneously represent (1) the public, in maintaining

standards for the production of physicians and in determining the quantity to be produced, and (2) the medical profession, the purveyors of medical services. In other words, the AMA represents both the buyers and sellers of physicians' services. It is hard to believe that the AMA, in this anomalous position, does not in fact primarily support physicians given that its own members are physicians.

V. ELEMENTS OF A STRUCTURAL SUPPLY FUNCTION

Having examined then the background of physician supply studies, the physician shortage as compared to the engineer shortage of the 1950's and the restrictive policies of the AMA, one arrives at the fundamental question: What factors influence a student to decide to become a physician? After considering possible explanations, a framework which an economist might utilize will be presented. Then an analytic form of a supply function will be introduced suggesting explanatory variables for both the short run and the long run solutions. An economist emphasizes the financial incentives, both present and future, as well as non-monetary but quantifiable parameters. These are items concerning which one could gather data and finally test hypotheses. Consequently this area will be emphasized in this paper. That is not to say that there are no other considerations. To the contrary, physicians have traditionally extolled the virtues of their profession as an opportunity to help mankind. Although some medical students may show a tendency toward "people orientation," one is hard pressed to quantify this trait and its effect on potential applicants. Educators may suggest that aptitude as evidenced by undergraduate grades, Medical College Admission Test (MCAT) scores and their influence on the probability of being accepted into medical school and its successful completion are important. And any education is partially for consumption as well as for investment. One

cannot easily discount these factors and their probable relevance, given the uncertainty regarding their weights. Finally, there are a host of non-monetary and non-qualifiable factors which enter into the decision, i.e. parental status, pressure, and influence; family status (single or married); cultural and attitudinal consideration; the non-monetary costs and benefits associated with being a physician as compared with those which could be expected in alternative careers.

A. FOUNDATION

Tibor Scitovsky, in his survey of trends in international professional earnings found "that it pays to be a high civil servant in England, a university professor in Germany and a physician in the United States" [36]. In this chapter then, all the quantifiable considerations (monetary and otherwise) of the potential applicant will be examined, taking the non-quantifiable considerations as a constant or given.

The most immediate concern, which has considerable impact, is the "cost" of attending medical school. These "out-of-pocket" costs are those which must be borne by the student after scholarships, grants, etc. They include not only tuition and books, but those living expenses which can vary widely depending on family status and location. Crocker and Smith found the average annual school expenses faced by the M.D. candidate in 1967-68 averaged $4,394 [37].

As an aside, these costs affect the socioeconomic characteristic of the representative M.D. candidate and lead to a biased distribution of these characteristics in the current medical student body. Not only do these costs impact on the decisions of potential applicants to medical school, but they affect the behavior of persons who complete their medical training and enter practice. Fein and Weber present a typical scenario: High costs of medical education bar many able but needy students from the field. Thus physicians are drawn largely from one stratum of the society, which does not fully understand the medical and other problems of the low income or minority groups. Such physicians, therefore, do not serve those persons adequately. Furthermore, having gone into debt during their long period of education and being older than others beginning to earn incomes when they finally enter medical practice, they tend to exact high fees.

As Table III shows, however there are undoubtedly other factors which cause the number of applicants to medical school to change radically.

Although actual openings have some positive effect, legislation opening the capital market seems to have a more pronounced effect. The enactment of "The Health Profession Educational Assistance Act," of 1963 provided federal loans and scholarships. The next two school years witnessed jumps of nearly 2000 in numbers of applicants. The Health Manpower Act of 1968 seemingly produced jumps of 3000 applicants in

TABLE III

Medical School Applicants, Openings and

Applicant to Opening Ratio

School Year	Number of Applicants	Number of Openings	Applicant/ Opening Ratio
1954-55	14,538	7,878	1.845
55-56	14,937	7,969	1.874
56-57	15,917	8,263	1.926
57-58	15,791	8,302	1.902
58-59	15,170	8,366	1.813
59-60	14,952	8,512	1.757
60-61	14,397	8,560	1.682
61-62	14,381	8,682	1.656
62-63	15,847	8,959	1.769
63-64	17,668	9,063	1.949
64-65	19,168	9,043	2.120
65-66	18,703	9,012	2.075
66-67	18,250	9,125	2.000
67-68	18,724	9,702	1.930
68-69	21,117	10,092	2.092
69-70	24,465	10,514	2.327
70-71	24,987	11,500	2.173
71-72	29,172	12,335	2.365
72-73	36,135	13,757	2.661

[38]

the next two school years. Finally, after passage of the Comprehensive Health Manpower Act of 1971 with emphasis on capitation grants for increased enrollment, there were increases of nearly 5000 applicants in each of the next two years. It would seem that each separate piece of legislation was effective in convincing a certain number of students of the possibility they now have of becoming a physician. It is understood that other factors enter in, but the impact of legislation opening the capital market cannot be dismissed in the enfranchisemnet of physicians.

Although medical students, through tuition, provide only about five percent of the total income of medical schools,

they bear the major portion of the costs of medical education. This is because (1) a substantial portion of the total expenditures of medical schools supports the production of outputs other than medical education and (2) opportunity costs must be included in the computation of the costs of medical education. Fein and Weber (in 1966) computed that opportunity costs, as measured by the median earnings of males with at least four years of college, represent 93 percent of the personal costs of medical education in public medical schools, 83 percent in private schools, and 100 percent for interns and residents [39].

A greater recognition of the importance of foregone income and of the long period of education and training after completion of the four years of undergraduate medical school would help focus attention on the problems associated with internship and residency training. Though there is little that the individual prospective physician can do to shorten the time spent in medical school, he can shorten the period between the receipt of the degree and his entry into independent practice by his decision regarding specialization or general practice. Economic considerations are important and influence the length of training beyond the M.D. and the career choices of the physician. Lyden, Geiger and Peterson found that debt at graduation was associated with the choice of the type of internship. The respondents who indicated that they had curtailed their training below what they had desired most often indicated that they were deterred for

economic reasons. Family financial support played a most important role in making long residency training possible; in 80 percent of the cases those with four or more years of residency had parental support for the major portion of their educational costs [40].

Financial considerations have other important impacts as well. The opportunity costs for studying while in high school may require that the individual in a low-income family substitute work for study, thus perhaps reducing academic performance and the probability of college acceptance. In addition, of course, the chance of attending college is lessened by the need to meet out-of-pocket costs and by the opportunity costs involved in such attendance. The student from a low-income family may have to go to work to help support his family and will have considerable difficulty in borrowing funds to finance his college expenses. Even if admitted to college, he may have to substitute work for study and perhaps, as a result reduce the level of his academic performance. Thus, he may lower his probability of acceptance into a medical school which places a premium on previous academic accomplishment as an indicator of academic potential and whose admissions committee does not accept "effort" as a partial substitute for "accomplishment." Finally, of course, the student must face the considerable expenses involved in attending medical school and the very significant opportunity costs that stretch over a relatively long period of time.

To put it in another way, a student considering the extension of his formal education can be expected to take account of the streams of monetary costs and benefits which will accrue from his decision. There are a variety of ways that these streams can be combined to provide a ranking of alternative actions. The most frequently used procedure is to compute the internal rate of return. This procedure requires the computation of the discount rate which equates the present value of the revenue stream and the present value of the cost stream. The costs would have to include both the explicit expenditures for education (tuition, books, materials) and the implicit costs of foregone earnings. A typical method for the student to choose in calculating the future benefit stream is the current age-income relationship (possibly adjusted for a real growth rate).

Table IV from Medical Economics listing the median net incomes of physicians from 1962-1971 includes the CPI deflated incomes and may also be used by the student.

"Medical Economics" feels that this past growth rate (5.4 percent 1962-1966) was a reliable indicator for the future, for they said in 1968, "All things considered, the median net income of all private M.D.'s under 65 will probably rise an average of 5.4 percent in each of the next ten years. That's a lower rate of gain than in the past, based on the assumption that more restraint will be exercised in raising fees. Conservatively, the typical private M.D. under

age 65 will net a projected $65,000 before income taxes in 1978" [41].

TABLE IV

Actual and Deflated Median Incomes of Physicians by Year

Year	Median Income	Deflated Median Income*
1962	$24,300	$26,827
1963	25,050	27,330
1964	28,380	30,537
1965	28,960	30,640
1966	32,170	33,103
1967	34,744	34,744
1968	37,620	36,115
1969	40,550	36,941
1970	41,500	35,690
1971	42,700	35,185

*Median incomes deflated by CPI (base year 1967) [42]

Another factor which may affect decisions is the perceived variability of income, particularly if the prospective applicant feels he will have to go into debt in order to finance the completion of his medical education. A better measure than standard deviation, in view of the skewed distribution of physicians' incomes, is the proportion of physicians whose earnings are under a specified low level or over a specified high level. Again "Medical Economics" provides the results of a survey which showed in 1966 only three percent of physicians in full-time practice earned less than $10,000 and fifteen percent earned less than $20,000. Thirty percent earned $40,000 or more and fifteen percent earned $50,000 or more [43].

In his doctoral disertation, Sloan included a study of internal rates of return to physicians' education. Using the incomes of physicians in different age groups through age 65 in a particular year to construct a revenue stream and the incomes of college graduates at different ages for the major part of the cost stream, he produced the following table:

TABLE V

Sloan's Estimates of Internal Rates of Return to Physicians' Education, Selected Years 1941-1966 in Percentages

1941	13.2
1947	17.9
1959	14.7
1962	16.6
1963	15.9
1964	16.1
1965	17.5
1966	18.2

[44]

Hansen calculated a comparison of rates of return to physicians, dentists and male college graduates resulting in the following:

Year	Male College	Dentists	Physicians
1939	.98	13.7	13.5
1949	1.16	11.5	13.4
1956	1.10	11.6	12.6

[45]

In a more recent study Sloan found that the internal rate of return on M.D. degrees with specialization was roughly 24 percent in 1965 [46]. Whereas Borland and Yett calculated the rate of return earned by males on a B.S. degree to be 14.8 percent [47], Fein and Weber calculated

estimates of internal rates of return earned on medical education ranging from a low of 15.1 percent to 33.6 percent for physicians [49].

B. FORMULATION

How then might one specify a system of structural equations to explain the supply of physicians in a particular year? It is clear that the number of physicians supplied in year t (S_t) is an identity composed of those medical graduates, domestic and foreign, who are licensed. That is, the supply can be broken down as follows:

$$S_t \equiv GPDL_t + \sum_{i=1}^{n} SPDL_t^i + GPFMGL_t + \sum_{i=1}^{n} SPFMGL_t^i$$

where

$GPDL_t$ = domestic medical graduates who are licensed for general practice in year t

$SPDL_t^i$ = domestic medical graduates who are licensed for the ith specialty practice in year t

$GPFMGL_t$ = foreign medical graduates who are licensed for general practice in year t

$SPFMGL_t^i$ = foreign medical graduates who are licensed for the ith specialty practice in year t

n = number of specialties in the medical profession

Looking first at domestic medical graduates, one can identify a number of factors which determine its magnitude. For example, the number of domestic graduate students who are licensed depends on the number of graduate students

three years ago since this is the minimum time between graduation and licensure for any physician. Further, this quantity is dependent on the net median income of general practitioners and finally on the compensation received in residency compared to that which could presently be earned elsewhere with the same training. That is:

$$GPDL_t = g_t(GS_{t-3}, NMI_t^{gp}, NMI_t^i, RS_t^R)$$

where

GS_{t-3} = medical student graduates in year t-3

NMI_t^{gp} = net median income of general practitioners in year t

NMI_t^i = net median income of a physician in the ith specialty in year t

RS_t^R = salary earned in residency relative to potential salary with present training in year t

When looking at specialties one must be concerned with graduates from medical school four and five years ago to account for the additional years required in residency for specialty licensure. In this case net median income of the specialty as compared to net median income of general practice must be considered. Again the relative compensation earned in residency must be considered. So,

$$SPDL_t^i = s_t^i(GS_{\overline{t}^i}, NMI_t^{gp}, NMI_t^i, RS_t^i)$$

where

$GS_{\overline{t}^i}$ = medical school graduates in the year lagged associated with the ith specialty training

NMI_t^{gp} = net median income of general practitioners in year t

NMI_t^i = net median income of a physician in the ith specialty in year t

RS_t^i = salary earned in residency working toward the ith specialty relative to the potential salary with present training in year t

Note that the subscript $\bar{t}^i$ would indicate the vector lag associated the additional years in residence required for specific specialties. Also RS_t^i would have more significance in the specialty equations than it would in the general practice equations.

Foreign medical graduates licensed is naturally dependent on the number of medical graduates allowed to immigrate into the U.S. and the subset of those which are allowed to stay upon fulfilling their internship and residency requirements. Congressional action has had a great part to play in the determination of this quantity. For example, whereas nearly 2000 foreign medical graduates returned to their respective countries per year prior to 1970 legislation, only 300 per year have elected to do so since. Legislation in the 1970's relaxed restrictive quotas for skilled immigrants threrby encouraging more professionals and especially physicians to remain in the United States to practice. Therefore, whether considering general practice or specialties:

$$FMGL_t = f_t(FMG_{\bar{t}^i}, CA)$$

where

FMGL = foreign medical graduates licensed in year $t \equiv GPFMGL_t + SPFMGL_t$

$FMG_{\bar{t}^i}$ = foreign medical graduates immigrating into the United States in year $\bar{t}^i$

CA = congressional action allowing more foreign medical graduates to stay in the United States

Clearly this is a section which will require more investigation and research. It is not clear whether foreign physicians have come to the United States primarily to learn with the intention of returning to their native countries or whether they have immigrated not only to learn as interns and residents but to stay in the United States to practice after comparing expected earnings in the United States with those possible in their native countries. It is necessary to investigate whether the allowable limit of immigrants is reached and if not, what influences the changes year by year.

Graduating students in any year clearly is another identity composed of the number of entering students less the attrition or drop-out during the four years spent in medical school. Thus:

$$GS_t = ES_{t-4} - \sum_{t-4}^{t} DO_t$$

where

ES_{t-4} = number of students entering medical school in year t-4

DO_t = drop-out or attrition per year t of medical school

It is to be noted that the variable entering students (ES) has been identical to capacity (C) as set forth by the AMA, i.e. capacity is the total number of entering students which have been accepted. So:

$$ES_{t-4} \equiv C_{t-4}$$

where C_{t-4} = capacity of medical schools as measured by first year acceptances

Capacity of medical schools is a function of a base capacity (intercept) in an intital year, and seems to be affected by a lagged number of applicants. That is with an increased number of applicants, there is a corresponding increase in pressure on medical schools to enlarge their enrollment. Should the applicant-to-opening ratio climb as high as five, medical schools might find it difficult to maintain their present restrictive policies and might yield to public pressure to accept more students and/or construct additional buildings. Of course increase in capacity would also be influenced by the advances in technology as well as inflation. Through technological advances, medical schools may be able to handle more students with existing facilities. Conversely equipment costs associated with construction may prohibit new construction given revenue expectations. Finally as evidenced earlier, congressional legislation can have a profound effect on influencing medical schools to increase their enrollments and conversely without congressional pressure, expansion might be resisted. Therefore:

$$C_t = c(C_o, NA_{t-}, IAT, LA)$$

where

C = initial intercept capacity in year t

NA_{t-} = number of applicants to medical school (lagged to reflect realization and construction delays)

IAT = inflation and technology advanced

LA = legislative action encouraging increased enrollments in medical schools

The number of drop-outs in any particular year may be dependent on the particular year, again the net median income as a proxy of expected earning in the future, the average annual cost of attendance in medical school, and congressional action granting loans, fellowships, grants, etc. Thus:

$$DO_t = d_t(t, NMI, AC_t, CFA)$$

where

NMI = net median income

AC_t = average annual cost of medical school attendance in year t

CFA = congressional (fellowship, grants, loans) action

t = particular year

Finally the number of applicants is influenced by net median income again, as a proxy for expected earnings in the future, the annual cost as a proxy for the expected outlay during their schooling, the acceptance rate in previous years and again congressional action enabling certain students to

attend whereas they had not previously been able to consider such action. Therefore:

$$NA_t = n_t(NMI_{\overline{t}}, AC, a_t, CFA)$$

where

$NMI_{\overline{t}}$ = net median income during a certain vectored period of years

AC = average annual cost

CFA = congressional (fellowship, grants, loans) action

$a_t = \frac{ES_{\overline{t}}}{NA_{\overline{t}}}$ = acceptance rate ($\overline{t}$ = vector of past years)

VI. NAVY PHYSICIAN SUPPLY

An interesting subset of the physician supply problem is the military physician supply and retention problem. Shortly after the President's Commission on an All Volunteer Force reported to the President on February 20, 1970 that an all volunteer force would better serve the nation's interest, steps were taken in that direction. By January 1973 the draft ended for all but physicians and dentists, and in July, 1973 all induction authority ended. This meant that the Armed Services had to compete in the civilian market for medical officers for the first time in 33 years. Since only one-sixth served voluntarily and one-sixth in repayment of obligations incurred through medical training programs subsidized by the Department of Defense, this left fully two-thirds serving because of the doctor draft. Compounding the physician shortage discussed earlier are the pay gaps between the military medical officer and his civilian counterpart. Given the considerations above which influence a person to become a physician, what further induces the physician to make a career decision in the military? Again there are monetary and non-monetary decisions, which include potential earnings, available facilities and equipment, security, prestige, opportunities for further education and research, type of patient, patient-physician relationships, etc.

During the past twenty years there have been a variety of studies identifying factors which affect the retention

of medical officers. Reviewing thirteen studies from 1956 to 1967, (see Appendix A) Jacox developed a deficiency rating system and provided a rank order of negative factors from his review of the literature and compilation of DOD statistics. Beginning with the most critical, they were: (1) instability, (2) salary, (3) career mangement, (4) housing, (5) assignments, (6) professional leadership, (7) family life, (8) prestige, (9) undesirable location, (10) quality of medical care, and (11) physician-patient relationship [49].

Dorman referred to AMA studies which uncovered eight reasons given by physicians and their wives for not choosing a permanent military career. In order of importance they were: insufficient pay, inadequate housing, frequent moves, separation from family, inadequate or interrupted schooling for children, lack of recognition and prestige, dislike for military social life, and undesirable duty locations [50].

A recent study by C. L. Braunstein canvassed Navy physicians and considered a "target group" as those who were either undecided about service plans or intended to remain but not necessarily until retirement. The most popular proposal was to increase total pay to the income earned by civilian practitioners with equivalent qualifications. Sixty-one percent would be "greatly encouraged to stay" and 23.3 percent would be "moderately encouraged to stay." Although the second most important proposal dealt with staying in one location for eight to twelve years, the third proposal enacting

a pay package that would boost the pay of junior medical officers reflected the monetary priority of the target group [51].

A DOD survey of military medical officers contained twelve possible proposals. The most popular was to "obtain authorization to pay physicians the amount they could earn outside military service." As a matter of fact, 36.3 percent of those responding indicated they would stay with that policy change [52].

With these studies as a background, the Department of Defense has devised two economic instruments to replace conscription as a means of obtaining and retaining physicians:

1. The medical scholarship program of Sept 1972
2. A special bonus for physicians of May 1974 (see Appendix B)

Under the scholarship program the military pays for tuition, fees, books, and lab expenses for up to four years of medical education; the medical student also receives about $5000 per year. In return he agrees to serve one year in the military for each year he participates in the program, with a minimum obligation of two years.

E. J. Devine of the Center for Naval Analyses, constructed a version of the standard economic model of occupational choice between military and civilian careers to evaluate the financial attractiveness of military service to a physician. During the first four years of medical school and the next four years of internship and residency the Navy income was

higher than civilian income. During the next four years, however, the Navy physician is actually repaying the subsidy and civilian income exceeds Navy income by its greatest amount. But with the maximum $13,500 bonus, military pay again would exceed civilian pay during the last five years of service. Upon retirement from the military, Devine assumed a physician capable of earning the same as his civilian counterpart and drawing military retirement pay in addition.

Comparing present values, the entrant into medical school would see a higher present value of Navy pay over civilian pay -- even with no bonus, undiscounted and at rates of five and ten percent. At the end of obligated service the same is true except at the ten percent rate.

He concluded (1) the financial advantages of the scholarship program were sufficient to fill all authorized scholarships,[1] (2) the scholarship was generally a good investment compared with the alternative procurement methods analyzed, provided no bonus was paid during the years of obligated service, and (3) it does not pay the military to retain a scholarship recipient for a 20 year career compared with investing in a succession of scholarship recipients who serve the initial obligation only [53].

Consequently the scholarship program is evaluated to be the major source of accessions in the near future.

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[1] Roughly 1100 positions for Navy students at any one time.

The bonus is viewed as both an acquisition and retention device. The bonus simply makes the scholarship program all the more attractive. In the one case where there was a higher present value in the civilian career at a ten percent discount, the Navy with the bonus would be more attractive.

Consequently Devine concludes that (1) although the bonus will increase retention, the amount of increase is unknown, (2) the bonus is superior to continuation pay since it permits a restructuring of the income experience profile so it more closely resembles that in the civilian sector and (3) the bonus is not large enough to attract unobligated post-residents into the military.

In addition to the above mentioned enactments, Congress has approved a uniformed services university of health sciences recently. To be located near Washington, D.C., the first students will enter next year. The first 50 medical students will graduate in 1979, 125 the year after, and no less than 100 annually thereafter. The students will be commissioned officers serving on active duty in pay grade O-1 with full pay and allowances of that grade. Students who graduate are required, unless exempted, to serve for not less than seven years. It is intended that the group will comprise a small, steady position of the physician needs of the Armed Services, much as the academies provide a nucleus of the line officer requirements.

Admiral Custis, Surgeon General of the Navy and Chief of the Bureau of Medicine, sees less problems with the recruitment

program than with the Navy retention program. He states that the "scholarship programs are extremely popular and fully subscribed. The interest in Navy internships is excellent. Navy residency training programs, always highly regarded because of their superior quality are well accepted. Applications for the latter training are often in excess of need. However, a genuine problem exists when trying to interest the practicing physician in a Navy career" [54]. To this end he calls for congressional support in the following areas: (1) equitable pay for health professionals, (2) generous educational subsidies, and (3) support for the five-year medical construction program.

The disparity in incomes was also examined by the Health Personnel All-Volunteer Task Force. Utilizing a present value concept, they determined that none of the pre-compensation compared with the civilian compensation at any of four points: beginning of medical school, after completion of four, ten, and twelve years of active service [55]. Consequently they saw large problems in meeting personnel requirements in the Medical Corps without some sort of policy modification. Based on the results of a physician survey, they conclude "the change which would result in by far the largest increase in retention is equivalent income."

Admiral Custis provided the following table of five year projected requirements, on board strengths, predicted losses, known accessions and the resultant shortfalls:

Requirement Plan	4080	3841	3763	3763	3763
On Board Strength	3340	3052	2752	2362	2068
Predicted Losses	1790	1030	1000	900	715
Known Accessions	997	742	710	510	421
Shortfall	740	789	1011	1401	1395

[56]

These estimates were made assuming that Congressional support to make Navy medicine economically and professionally competitive with the private sector and that in-house initiatives would not be fruitful. Clearly the trend of shortfalls is catastrophic. In fiscal year 74 the shortfall is less than 50 percent of the predicted losses, by fiscal year 78, it is nearly 200 percent.

In consonance, then, with earlier chapters which indicate a person selects medicine as a career based on economic reasons such as expected net median income, a physician tends to leave the Navy when he cannot realize this expectation. The reason most frequently offered is that of equitable pay with the caveat that he could be persuaded to stay with an increase in compensation making his salary comparable to that of a civilian physician with similar qualifications.

Given then the present constraints of the Navy budget, it seems prudent to invest the Navy's money in scholarships helping the medical student to fund his education. Indications are that despite the immediate outlay, this method is

most attractive to students and will result in a greater supply to meet the quoted demand, and at least possibly increase retention above levels presently being experienced.

VII. CONCLUSION

In the first section of the thesis, the relevant literature was reviewed and a theoretical foundation was provided for a physician supply function. Subsequently a set of structural equations was proposed to explain factors affecting the supply of physicians. These equations were intended as a framework for econometric analysis of physician supply functions. Throughout the specification care was exercised to include only those variables in the structural equations that were quantifiable and for which sufficient data for estimation exists. With these terms, both monetary and otherwise, policies can be examined and their effects assessed. These equations then lay the framework for further research in this crucial policy area.

APPENDIX A

Lieutenant Colonel Gilbert L. Jacox used the following thirteen studies in his review of factors affecting the retention of Medical Officers:

1. Report of the Committee on Army Medical Education to the Surgeon General, United States Army, National Academy of Sciences, Washington, D.C., January 1956.

2. Factors Affecting the Career Intentions of U.S. Army Medical Officers, NORC, University of Chicago, June 1958.

3. Career Orientations of U.S. Army Medical Interns in Fiscal Year 1956 by Norman A. Hilmer, Captain MSC, OTSGDA, January 1958.

4. Report of an Opinion and Intention Survey of Physicians and Dentists on Active Duty, Department of the Air Force, 1962.

5. Review of Professional Medical Personnel Procurement and Training, Parts I & II, TSGDA, November 1965.

6. Navy Medical Care and Doctor Retention Problems, Office of the Surgeon General, U.S. Navy, November 1965.

7. Vanishing Career Military Physician?, American Medical Association Draft 1965.

8. Physicians in the Armed Services, Logistics Management Institute, Washington, D.C., March 1967.

9. Physicians and Dentists in the Uniformed Services, USPHS, (draft of an unpublished study, 18 July 1966).

10. Problems in Retention of U.S. Army Medical Corps Officers by Floyd W. Baker, LCOL, U.S. Army, ICAF, Washington, D.C., 1967.

11. Why Doctors Get Out, William A. Boysen, COL, MC, U.S. Army, War College, Carlisle Barracks, Pennsylvania, 7 April 1967.

12. Factors Influencing the Retention of Physicians in the Department of Defense, William D. Tribble, 1967.

13. Doctor Draft Justified? A Management Diagnosis, William D. Tribble, National Biomedical Laboratory, San Antonio, Texas, October 1968.

APPENDIX B

TENTATIVE PHYSICIAN BONUS

Number of Years Serving for Pay Purposes	Number of Years of Active Duty Agreeing to Serve			
4-13	$12,000	$12,500	$13,000	$13,500
14-19	11,500	12,000	12,500	13,000
20-25	11,000	11,300	11,600	12,000
26+	10,000	10,300	10,600	11,000
previously obligated officers	9,000	9,000	9,000	9,000

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